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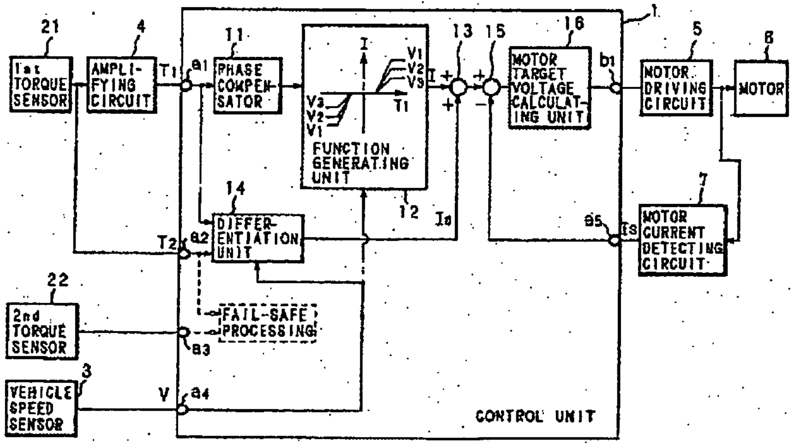
(54) Controlling apparatus for power steering.

(57) A controlling apparatus for power steering system is provided with a differentiation unit (14) in which a signal selecting element 144 judges whether a first torque detecting signal T_1 having a high gain is in a saturated range or not, outputs as a differential current I_d a first differential current I_{d1} obtained by differentiating the first torque detecting signal T_1 in the case where the first torque detecting signal T_1 is not in the saturation range, and outputs as the differential current I_d a second differential current I_{d2} obtained by differentiating a second torque detecting signal T_2 having a low gain in the case where the first torque detecting signal T_1 is in the saturation range to generate the differential current I_d in the case where the first for adjusting a control value of a driving current of a steering assisting motor (6), whereby it is possible to obtain a sufficient effect of differential control for a wide range of steering torque without producing an inharmonious feeling in steering feeling.

Fig. 1.



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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a controlling apparatus for an electrically-driven power steering system installed on an automobile.

Description of the Related Art

An electrically-driven power steering system installed on an automobile is designed to assist an operation force necessary for steering the automobile by using a motor, wherein its controlling apparatus is constituted such that, a torque sensor which detects a rotational force applied to a steering wheel and a motor which assists the operation of a steering mechanism are disposed on the steering mechanism to which the steering wheel is connected in an interlocking fashion through a shaft, and the operation force of the steering wheel is reduced by driving the motor responsive to detection values of the torque sensor.

In such a power steering system, there were problems of deterioration in responsibility of the steering mechanism and a phase delay in an electric circuit of the controlling apparatus due to the motor inertia and frictions of a reduction unit interposed between the motor and the steering mechanism. In order to solve the problems, a technique of adjusting a motor current by differentiating detecting signals of the torque sensor to cope with the deterioration and the like of the responsibility, for example, Japanese Patent Application Laid-Open No. 61-115771(1986) is known. This is constructed to perform a differential control, which operates the steering mechanism without a time delay by differentiating the detecting signal of the torque sensor, adding a differentiated signal to a temporary control value obtained responsive to the detecting signal of the torque sensor, and responding to a steering force detected by the torque sensor.

In an apparatus in which such differential control is implemented, the torque sensor detecting signal and a temporary target value of a motor driving current are functionally processed beforehand, the temporary target value of the motor driving current is decided from the torque sensor detecting signal by using this function, and the differentiated signal of the torque sensor detecting signal is added to this temporary target value to decide a final target value of the motor driving current. Then, the motor current was controlled so as to coincide with the decided target value to assist the steering. In this case, for example, such as the U. S. Patent Application No.686,107, an apparatus which uses a high gain signal obtained by amplifying the output signal of the torque sensor, or a low gain signal obtained by not amplifying the output signal of the torque sensor, as a detecting signal which is subject to the differential processing is known.

In a conventional controlling apparatus for a power steering system which performs the differential control as stated before, there were such problems as described hereinbelow. In case of using the high gain signal, though its differential amount is large, on the other hand, since this signal has a high gain, it is to be saturated above a predetermined torque, thus the differential control does not work and an inharmonious feeling such as a feeling of hooking is produced in steering feeling because the differential amount becomes zero in the saturated range. Meanwhile, in case of using the low gain signal, though the differential control works in a wide range of steering torque, on the other hand, since the differential amount is small, an effect of differential control is not obtained sufficiently, thus when its differential constant is increased to obtain the effect of differential control sufficiently, the differential value is liable to oscillate, thereby producing the vibration in steering.

SUMMARY OF THE INVENTION

The present invention has been devised in view of such circumstances, it is therefore a primary object thereof to provide a controlling apparatus for a power steering system, which is capable of obtaining a sufficient effect of differential control in a wide range of steering torque without producing an inharmonious feeling in steering feeling.

The controlling apparatus for the power steering system according to the present invention is constituted such that, the detection result of a torque sensor which detects a steering torque applied to a steering wheel is represented by a high gain first detecting signal which saturates in a predetermined torque range, and a second detecting signal whose gain is lower and which does not saturate in the predetermined torque range to decide a motor driving current responsive to the first detecting signal, and further, includes judging means for judging whether the first detecting signal is in the predetermined torque range, and means for adjusting the motor driving current on the basis of a differentiated signal of the first detecting signal in the case where it is judged that the first detecting signal is not in the predetermined torque range, and adjusting the motor driving current on the basis of a differentiated signal of the second detecting signal in the case where it is judged that the first detecting signal is in the predetermined torque range.

In such controlling apparatus for the power steering system of the present invention, though the motor driving current is adjusted on the basis of the differentiated signal of the first detecting signal in the case where the first detecting signal representing the detection result of the torque sensor is not saturated, since gain of the first detecting signal is relatively high and its differential value is large in this case, an adjusting amount of the motor driving current can be obtained sufficiently. Since the motor driving current is adjusted on the basis of the differentiated signal of the second detecting signal when the first detecting signal is saturated, the adjusting amount of the motor driving current can also be obtained in the torque range wherein the first detecting signal is saturated. Thereby, the adjusting amount of the motor driving current is obtained for a wide range of steering torque. In such a way, since the adjusting amount of the motor driving current is obtained even when the first detecting signal is saturated, the motor driving current is adjusted for the wide range of steering torque without producing the inharmonious feeling in steering feeling.

The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a configuration of a controlling apparatus for a power steering system according to the present invention,

Fig. 2 is a block diagram showing a specific configuration of its differentiation unit,

Fig. 3 is a graph showing an example of relationship between a steering torque and a signal voltage in a first torque detecting signal and a second torque detecting signal,

Fig. 4 is a flow chart for explaining the operation of a controlling apparatus for a power steering system of the present invention, and

Fig. 5 is a block diagram showing a configuration of a controlling apparatus for a power steering system showing another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, the present invention is specifically described on the basis of the drawings showing its embodiments. Fig. 1 is a block diagram showing a configuration of a controlling apparatus for a power steering system according to the present invention.

In Fig 1, numeral 1 designates a control unit including input ports a_1, a_2, a_3, a_4, a_5 and an output port b_1.

To the input port a_1, a detecting signal of a first torque sensor 21 which detects a rotational force applied to a steering wheel connected to a steering mechanism, not shown, in an interlocking fashion via a shaft, is given as a first torque detecting signal T_1 of a steering torque via an amplifying circuit 4 which sets a gain and upper/lower limit values. The first torque detecting signal T_1 has its voltage saturated by the amplifying circuit 4 in the case where the detected steering torque exceeds a detection range necessary for assisting the steering in a usual running state.

To the input port a_2, the detecting signal of the first torque sensor 21 which does not go through the amplifying circuit 4 is given as a second torque detecting signal T_2.

To the input port a_3, in the same way as the first torque sensor 21, a detecting signal of a second torque sensor 22 which detects a rotational force applied to the steering wheel connected to the steering mechanism, not shown, in an interlocking fashion via the shaft is given.

To the input port a_4, a vehicle speed detecting signal V which is an output of a vehicle speed sensor 3 detecting a vehicle running speed is given.

To an input port a_5, a current detecting signal Is which is an output of a motor current detecting circuit 7 detecting a driving current of a motor 6 which performs the steering assisting operation of the steering mechanism is given.

Meanwhile, to an output port b_1, a motor driving circuit 5 which drives the motor 6 is connected.

The first torque detecting signal T_1 inputted from the input port a_1 of the control unit 1 is given to a phase compensator 11 and a differentiation unit 14. The first torque detecting signal T_1 given to the phase compensator 11 has its phase proceeded and is given to a function generating unit 12. The function generating unit 12 inputs the first torque detecting signal T_1 which has been phase compensated, and outputs a target current I which is a temporary target value of the motor current.

In the function generating unit 12, as shown in Fig. 1, functions, thereby the target current I increases proportionally as the first torque detecting signal T_1 is increased when the first torque detecting signal T_1 exceeds a predetermined dead zone, and the target current I is saturated when, further, the first torque detecting signal T_1 exceeds a predetermined value, are decided variably responsive to the vehicle speed detecting signal V (where, $V_1 < V_2 < V_3$ such that, a ratio of target current I against the first torque detecting signal T_1 as well as a saturated value of the target current I become smaller, as the vehicle speed detecting signals V_1, V_2, V_3... become larger. In the function generating unit 12, the target value I is decided responsive to the first torque detecting signal T_1 given from the phase compensator 11 and given to an adder 13.

The second torque detecting signal T_2 inputted from the input port a_2 is given to a differentiation unit 14 having a configuration as to be described later, and at the same time, used as the fail-safe processing for interlocking various controlling apparatuses at troubles. To the differentiation unit 14, the vehicle speed detecting signal V is also inputted from the input port a_4 besides the first torque detecting signal T_1 and the second torque detecting signal T_2. In the differentiation unit 14, by a method to be described later, the first torque detecting signal T_1 and the second torque detecting signal T_2 are respectively differentiated, and compensated by using a differential constant decided responsive to the vehicle speed detecting signal V, and either of these results is given to the adder 13 as a differential current Id. In the adder 13, the target current I given from the function generating unit 12 and the differential current Id given from the differentiation unit 14 are added and the added result is given to a subtracter 15.

Also, the detecting signal of the second torque sensor 22 inputted from the input port a_3 is used for the fail-safe processing.

The current detecting signal Is inputted from the input port a_5 is given to the subtracter 15. In the subtracter 15, the current detecting signal Is is subtracted from the added result of the adder 13, and the subtracted result is given to a motor target voltage calculating unit 16. In the motor target voltage calculating unit 16, the given subtracted result is subjected to PID (Proportional plus Integral plus Derivative) calculation, and a PWM (Pulse Width Modulation) signal on the basis of the calculated result is given to the motor driving circuit 5 via the output port b_1.

Next, a detailed configuration of the differentiation unit 14 is described. Fig. 2 is a block diagram showing the configuration of the differentiation unit 14.

In the differentiation unit 14, the first torque detecting signal T_1 is given to a primary delay element 141a, a subtracting element 142a and a signal selecting element 144, respectively. In the primary delay element 141a, a primary delay signal is outputted against the first torque detecting signal T_1 which is the input signal, and a primary delay signal T_{L1} outputted from the primary delay element 141a is given to the subtracting element 142a. In the subtracting element 142a, the primary delay signal T_{L1} is subtracted from the first torque detecting signal T_1, and a differential value ΔT_1 which is its subtracted result is given to the gain element 143a. To the gain element 143a, a vehicle speed detecting signal V is given besides the differential value ΔT_1. In the gain element 143a, the differential value ΔT_1 is multiplied by a differential constant K_1 responsive to the vehicle speed detecting signal V, and the result is given to the signal selecting element 144 as a first differential current I_{d1}.

In the differentiation unit 14, the second torque detecting signal T_2 is respectively given to a primary delay element 141b and a subtracting element 142b. In the primary delay element 141b, the primary delay signal is outputted against the second torque detecting signal T_2 which is the input signal, and a primary delay signal T_{L2} outputted from the primary delay element 141b is given to a subtracting element 142b. In the subtracting element 142b, the primary delay signal T_{L2} is subtracted from the second torque detecting signal T_2, and a differential value ΔT_2 which is its subtracted result is given to a gain element 143b. The vehicle speed detecting signal V is also given to the gain element 143b besides the differential value ΔT_2. In the gain element 143b, the differential value ΔT_2 is multiplied by a differential constant K_2 responsive to the vehicle detecting signal V, and its result is given to the signal selecting element 144 as a second differential current I_{d2}.

In the signal selecting element 144, it is constituted such that, either the first differential current I_{d1} or the second differential current I_{d2} is selectively given to the adder 13 shown in Fig. 1 as the differential current I_d. Specifically, the signal selecting element 144 outputs the first differential current I_{d1} as the differential current I_d, in the case where the first torque detecting signal T_1 is not in its saturation range, meanwhile, outputs the second differential current I_{d2} as the differential current I_d in the case where the first torque detecting signal T_1 is in its saturation range. The differential current I_d outputted from the signal selecting element 144 is given to the adder 13.

Next, respective steering torque detection ranges of the first torque detecting signal T_1 and the second torque detecting signal T_2 are described. Fig. 3 is a graph showing an example of a relationship between a steering torque and a signal voltage in the first torque detecting signal T_1 and the second torque detecting signal T_2, wherein the signal voltage is plotted along the ordinate and the steering torque is plotted along the abscissa. With respect to the first torque detecting signal T_1, the relationship is shown by the one-dot-chain line, and with respect to the second torque detecting signal T_2, the relationship is shown by the solid line.

In the first torque detecting signal T_1, in the case where the detected steering torque exceeds a detection range which is necessary for assisting the steering in the usual running state, it voltage is saturated by the amplifying circuit 4. In the first torque detecting signal T_1, the detection range becomes an effective detection width of the steering torque. Meanwhile, in the second torque detecting signal T_2, since the signal is not amplified in the amplifying circuit 4 and is given directly to the input port a_2 from the first torque sensor 21, the signal gain is lower than that of the first torque detecting signal T_1. And hence, the effective detection width of the second torque detecting signal is wider than that of the first torque detecting signal T_1, and information of the steering torque in a range including the saturation range of the first torque detecting signal T_1 is obtained from the second torque detecting signal T_2.

The differentiation unit 14 outputs the differentiated result of the first torque detecting signal T_1 as a differential current I_d, in the case where the first torque detecting signal T_1 is not in its saturation range. Since the first torque detecting signal T_1 has a high signal gain, the sufficient differential current I_d for operating the differential control is outputted. The differentiation unit 14 outputs the differentiated result of the second torque detecting signal T_2 as the differential current I_d in the case where the first torque detecting signal T_1 is in its saturation range. Thus, it is possible to operate the differential control even in the saturation range of the first torque detecting signal T_1. And hence, a sufficient effect of the differential control can be obtained for a wide range of steering torque without producing an inharmonious feeling in steering feeling.

Next, the content of operation of the control unit 1 constituted as stated before is described with reference to a flow chart shown in Fig. 4.

First, the first torque detecting signal T_1 inputted to the input port a_1, the second torque detecting signal T_2 inputted to the input port a_2, the vehicle speed detecting signal V inputted to the input port a_4 and the current detecting signal I_s inputted to the input port a_5 are respectively read (Step S1). The first torque detecting signal T_1 read from the input port a_1 is subjected to phase compensation by a phase compensator 11 to proceed its phase (Step S2).

In a function generating unit 12, a target current I is decided on the basis of the first torque detecting signal T_1 whose phase is compensated and the vehicle speed detecting signal V given to the input port a_4 (Step S3).

In the differentiation unit 14, simultaneously with the processings in Steps S2 and S3, the differential value ΔT_1 of the first torque detecting signal T_1 is calculated (Step S4), and by multiplying the calculated differential value ΔT_1 by a differential constant K_1, the first differential current I_{d1} is obtained (step S5). Also, simultaneously with the processings in Steps S4 and S5, the differential value ΔT_2 of the second torque detecting signal T_2 is calculated (step S6), and by multiplying the calculated differential value ΔT_2 by the differential constant K_2, the second differential current I_{d2} is obtained (Step S7).

In the signal selecting element 144, it is judged whether the first torque detecting signal T_1 is in the saturation range (Step S8). In the case where it is judged that the first torque detecting signal T_1 is not in the saturation range, the first differential current I_{d1} as the differential current I_d is added to the target current I in the adder 13, and a final target current for driving the motor 6 is decided (Step S9). Meanwhile, in the case where it is judged that the first torque detecting signal T_1 is in the saturation range, the second differential current I_{d2} as the differential current I_d is added to the target current I in the adder 13, and a final target current for driving the motor 6 is decided (Step S10).

In the subtracter 15, the current detecting signal I_s given to the input port a_5 is subtracted from the final target current decided as stated before. The subtracted result by the subtracter 15 is subjected to the PID control in a motor target voltage calculating unit 16 to decide a target voltage of the motor (Step S11). The motor driving circuit 5 drives the motor 6 (Step S12) to assist the steering responsive to the PWM signal given from the motor target voltage calculating unit 16.

Fig. 5 is a block diagram showing a configuration of a controlling apparatus for a power steering system showing another embodiment of the present invention, wherein same or corresponding parts of Fig. 1 are designated by same reference characters and their explanation is omitted.

In Fig. 5, a point different from the controlling apparatus of Fig. 1 is the one where the detecting signal of the second torque sensor 22 is used as the second torque detecting signal T_2 in the differentiation unit 14. That is, originally it is arranged such that the detecting signal is given directly to the input port a_2 from the second torque sensor 22 which is the sensor for detecting the steering torque for the fail-safe processing as stated above, and such that said detecting signal is divided into the second torque detecting signal T_2 which is differentiated in the differentiation unit 14 and a signal which receives the fail-safe processing. It is also arranged such that, the detecting signal of the first torque sensor 21 is given to the input port a_1 via the amplifying circuit 4, and at the same time, given to the input port a_3, and the signal given to the input port a_3 serves as the signal for the fail-safe processing. Other configurations are as same as the embodiment shown in Fig. 1, and its operation is also same as that of the controlling apparatus shown in Fig. 1.

As stated above, in the controlling apparatus for the power steering system according to the present invention, in the case where the first torque detecting signal T_1 is not saturated, though the driving current of the motor 6 is adjusted on the basis of its differentiated signal, since the gain of the first torque detecting signal T_1 is relatively high and its differential value is large, an adjusting amount of the driving current of the motor 6 can be obtained sufficiently. In the case where the first torque detecting signal T_1 is saturated, since the driving current of the motor 6 is adjusted on the basis of its differentiated signal, the adjusting amount of the motor 6 is obtained even in a torque range wherein the first torque detecting signal T_1 is saturated. Thereby, it is possible to obtain the adjusting amount of the driving current control value of the motor 6 for a wide range of steering torque. As such, since the driving current adjusting amount of the motor 6 is obtained even when the first torque detecting signal T_1 is saturated, the present invention is very effective in obtaining the effect of differential control sufficiently for the wide range of steering torque, without producing an inharmonious feeling in steering feeling.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the meets and bounds of the claims, or equivalence of such meets and bounds thereof are therefore intended to be embraced by the claims.

Claims

1. A controlling apparatus for power steering system including a torque sensor (21) for detecting steering torque applied to a steering wheel, and a steering assisting motor (6) which is driven on the basis of a detecting signal of said torque sensor (21), comprising:

   means (12) for generating a driving current of said motor (6) responsive to the detecting signal of said torque sensor (21);

   means (4) for amplifying the detecting signal of said torque sensor (21) to a first torque detecting signal (T_1);

   differentiation means (14) for differentiating said first torque detecting signal (T_1) and the unamplified detecting signal of said torque sensor (21) as a second torque detecting signal (T_2), compensating each differentiated signal responsive to a detected signal of a vehicle state, and selectively outputting either of compensated signals corresponding to said first torque detecting signal (T_1); and

   means (13) for adjusting the driving current of said motor (6) on the basis of the signal outputted from said differentiating means (14).

2. A controlling apparatus for power steering system as set forth in claim 1, wherein said detected signal of the vehicle state is a vehicle speed detecting signal (V) detected by a vehicle speed sensor (3).

3. A controlling apparatus for power steering system including a torque sensor (21) for detecting steering torque applied to a steering wheel, and a steering assisting motor (6) which is driven on the basis of a detecting signal of said torque sensor (21), comprising:

   an amplifying circuit (4) which amplifies said detecting signal of said torque sensor (21) and outputs a first torque detecting signal (T_1) which saturates in a predetermined torque range;

   a function generating unit (12) which converts said first torque detecting signal (T_1) according to a predetermined function to generate a driving current of said motor (6);

   a differentiation unit (14) having:

   elements (141a, 142a) which differentiate said first torque detecting signal (T_1);

   elements (141b, 142b) which differentiate the detecting signal of said torque sensor (21) as a second torque detecting signal (T_2);

   a first compensating element (143a) which compensates the differentiated signal of said first torque detecting signal (T_1) corresponding to a detected signal of a vehicle state;

   a second compensating element (143b) which compensates the differentiated signal of said second torque detecting signal (T_2) corresponding to said detected signal of the vehicle state;

   a selecting element (144) which judges whether said first torque detecting signal (T_1) is in said predetermined torque range or not, outputs the output signal of said first compensating element (143a) in the case where said first torque detecting signal (T_1) is not in said predetermined torque range, and outputs the output signal of said second compensating element (143b) in the case where said first torque detecting signal (T_1) is in said predetermined torque range; and

   an adder (13) which adds the signal outputted from said differentiation unit (14) and the driving current of said motor (6) for adjustment.

4. A controlling apparatus for power steering sys-

tem as set forth in claim 3, wherein said detected signal of the vehicle state is a vehicle speed detecting signal (V) detected by a vehicle speed sensor (3).

5. A controlling apparatus for power steering system including a first torque sensor (21) and a second torque sensor (22) for detecting steering torque applied to a steering wheel, and a steering assisting motor (6) which is driven on the basis of a detecting signal of said first torque sensor (21), comprising:

means (12) for generating a driving current of said motor (6) responsive to said detecting signal of said first torque sensor (21);

means (4) for amplifying said detecting signal of said first torque sensor (21) to a fist torque detecting signal (T_1);

differentiation means (14) for differentiating said first torque detecting signal (T_1) and the unamplified detecting signal of said second torque sensor (22) as a second torque detecting signal (T_2), compensating each differentiated signal responsive to a detected signal of a vehicle state, and selectively outputting either of compensated signals corresponding to said first torque detecting signal (T_1); and

means (13) for adjusting the driving current of said motor (6) on the basis of the signal selectively outputted from said differentiation means (14).

6. A controlling apparatus for power steering system as set forth in claim 5, wherein said detected signal of the vehicle state is a vehicle speed detecting signal (V) detected by a vehicle speed sensor (3).

7. A controlling apparatus for power steering system including a first torque sensor (21) and a second torque sensor (22) for detecting steering torque applied to a steering wheel, and a steering assisting motor (6) which is driven on the basis of a detecting signal of said first torque sensor (21), comprising:

an amplifying circuit (4) which amplifies the detecting signal of said first torque sensor (21) and outputs a first torque detecting signal (T_1) which saturates in a predetermined torque range;

a function generating unit (12) which converts said first torque detecting signal (T_1) according to a predetermined function to generate a driving current of said motor (6);

a differentiation unit (14) having:

elements (141a, 142a) which differentiate said first torque detecting signal (T_1);

elements (141b, 142b) which differentiate the detecting signal of said second torque sensor (22) as a second torque detecting signal (T_2);

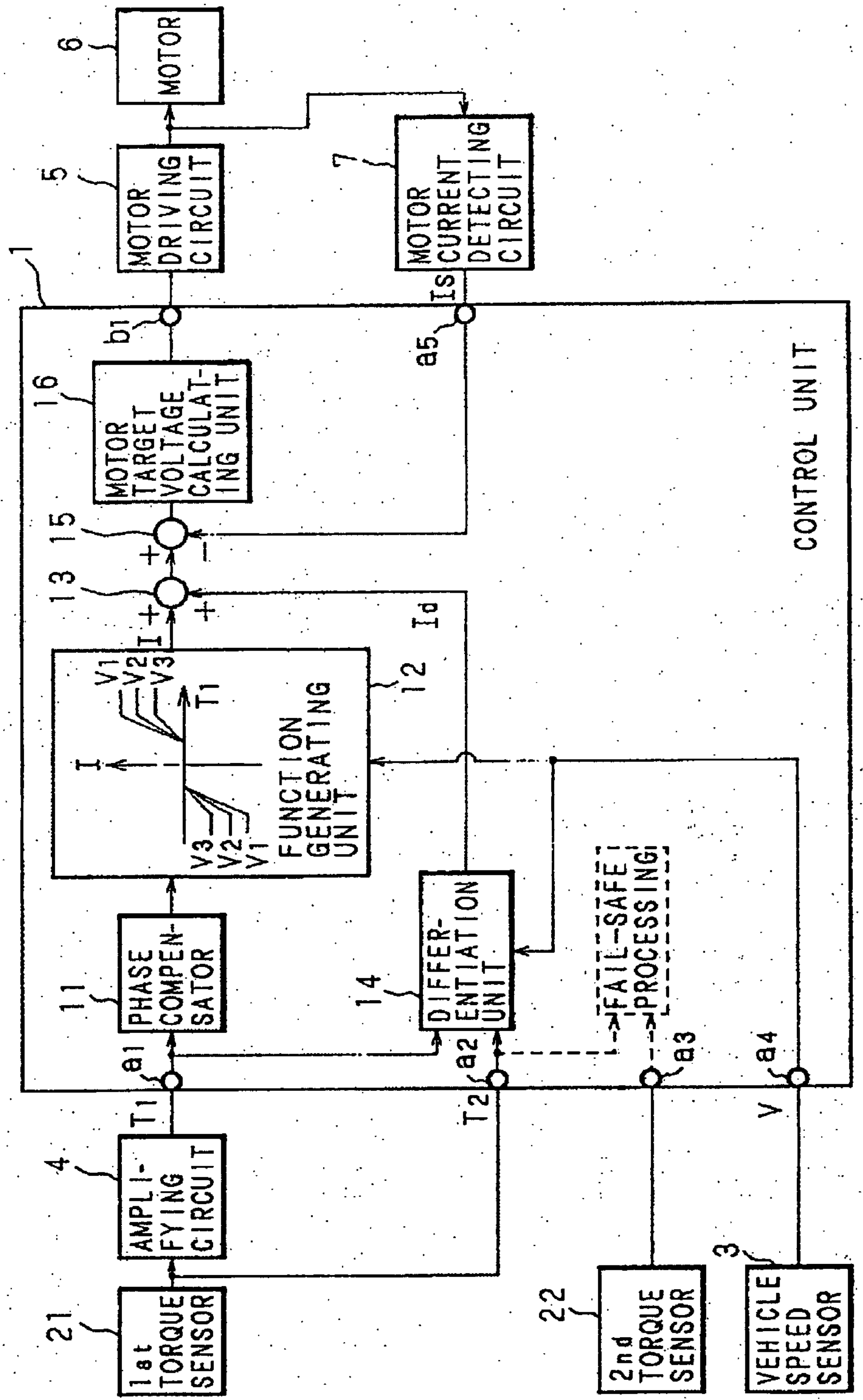
a first compensating element (143a) which compensates the differentiated signal of said first torque detecting signal (T_1) corresponding to a detected signal of a vehicle state;

a second compensating element (143b) which compensates the differentiated signal of said second torque detecting signal (T_2) corresponding to said detected signal of the vehicle state;

a selecting element (144) which judges whether said first torque detecting signal (T_1) is in said predetermined torque range or not, outputs the output signal of said first compensating element (143a) in the case where said first torque detecting signal (T_1) is not in said predetermined torque range, and outputs the output signal of said second compensating element (143b) in the case where said first torque detecting signal (T_1) is in said predetermined torque range; and

an adder (13) which adds the signal outputted from said differentiation unit (14) and the driving current of said motor (6) for adjustment.

8. A controlling apparatus for power steering system as set forth in claim 7, wherein said detected signal of the vehicle state is a vehicle speed detecting signal (V) detected by a vehicle speed sensor (3).


1st TORQUE SENSOR
21
AMPLI-FYING CIRCUIT
4
2nd TORQUE SENSOR
22
VEHICLE SPEED SENSOR
3
T1
T2
V
a1
a2
a3
a4
a5
b1
Is
PHASE COMPEN-SATOR
11
DIFFER-ENTIATION UNIT
14
FAIL-SAFE PROCESSING
FUNCTION GENERATING UNIT
12
I
T1
V1
V2
V3
Id
13
15
+
+
+
−
MOTOR TARGET VOLTAGE CALCULAT-ING UNIT
16
CONTROL UNIT
1
MOTOR DRIVING CIRCUIT
5
MOTOR
6
MOTOR CURRENT DETECTING CIRCUIT
7

F i g. 1

Fig. 2

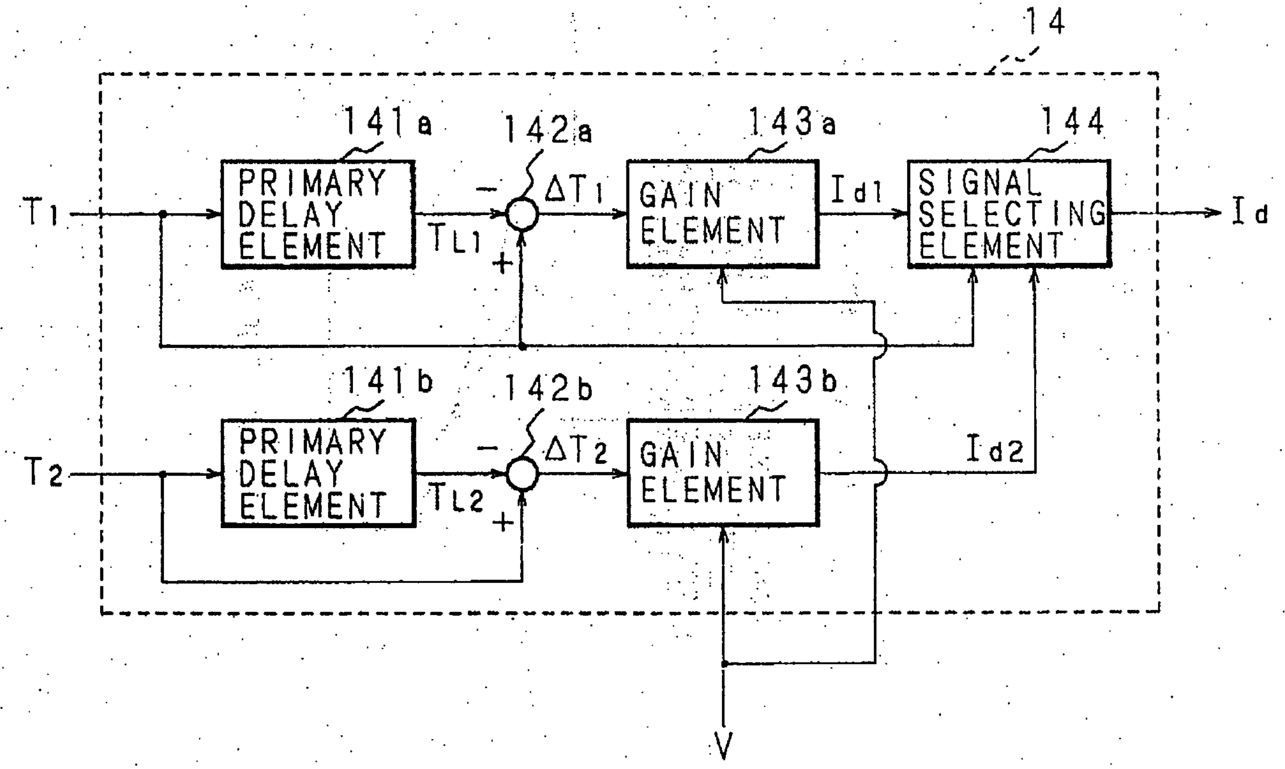

14
141a
142a
143a
144
T1
PRIMARY DELAY ELEMENT
TL1
−
+
ΔT1
GAIN ELEMENT
Id1
SIGNAL SELECTING ELEMENT
Id
141b
142b
143b
T2
PRIMARY DELAY ELEMENT
TL2
−
+
ΔT2
GAIN ELEMENT
Id2
V

Fig. 3

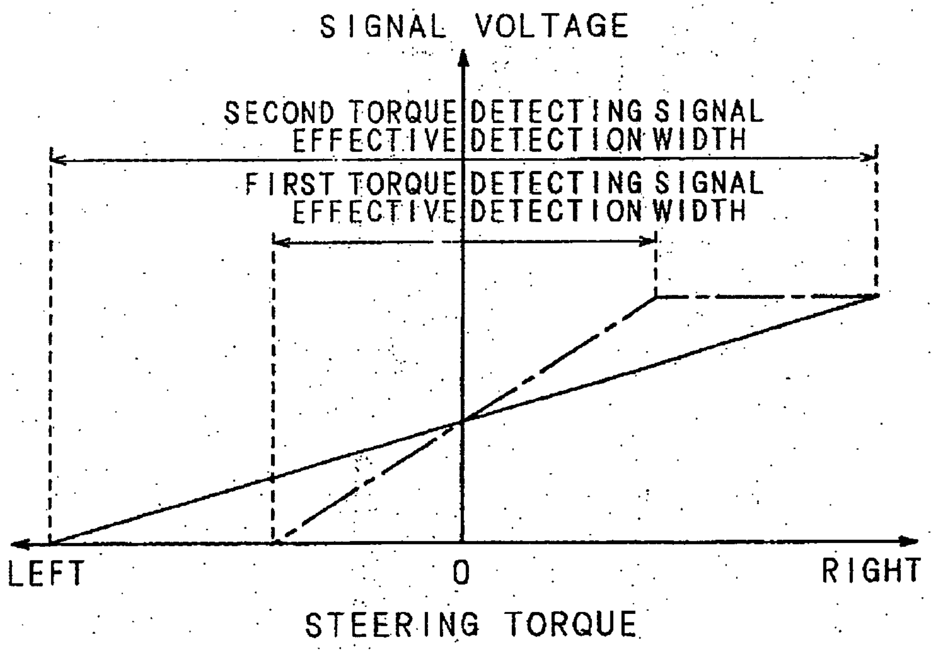
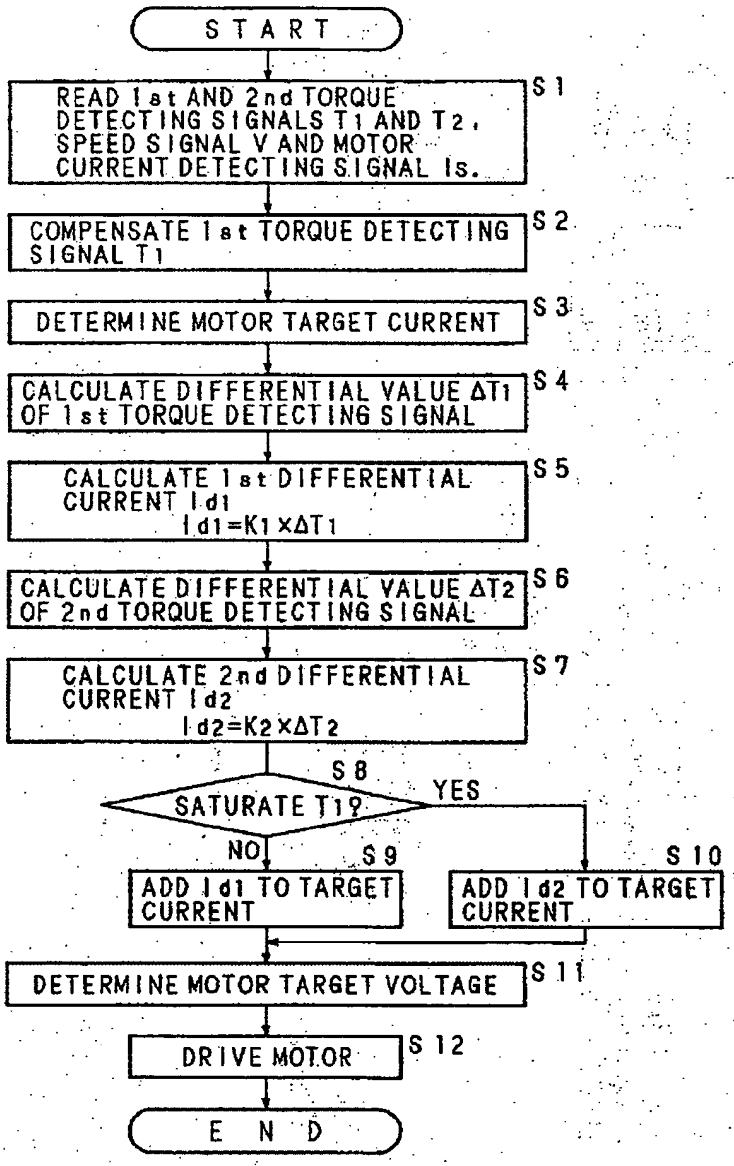
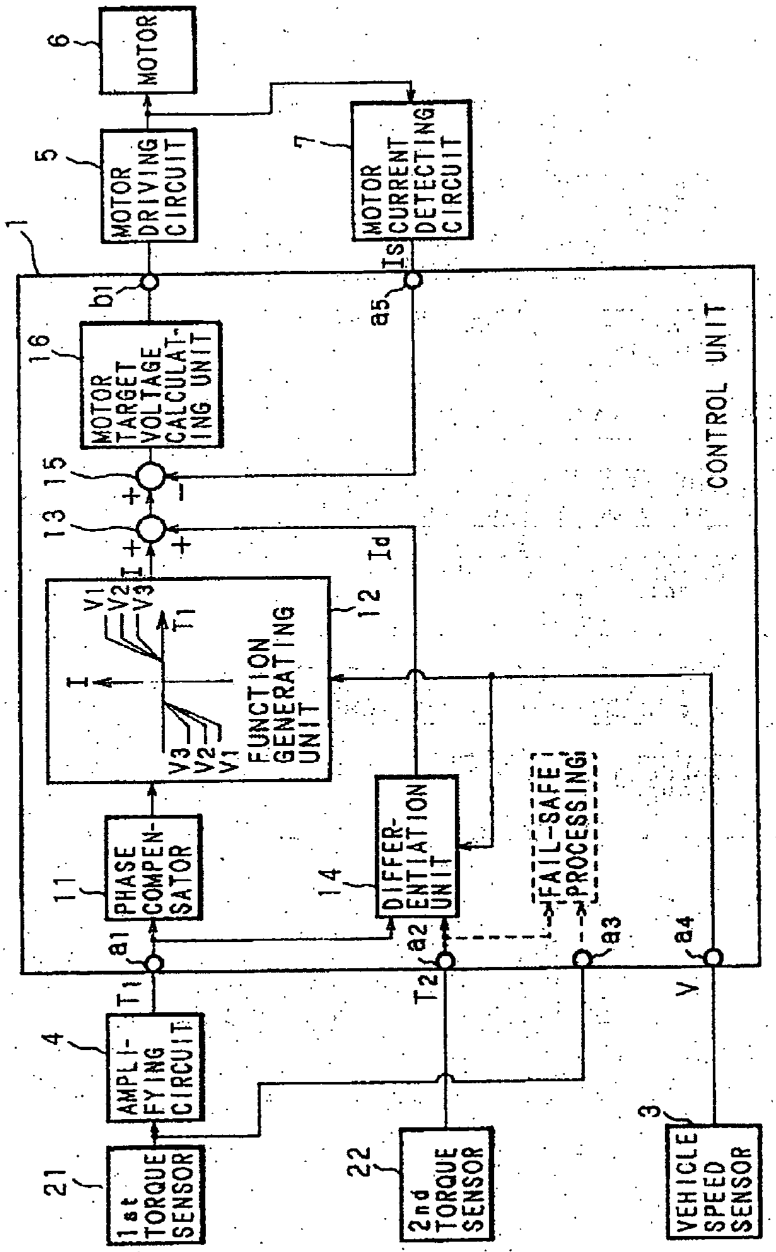

SIGNAL VOLTAGE
SECOND TORQUE DETECTING SIGNAL EFFECTIVE DETECTION WIDTH
FIRST TORQUE DETECTING SIGNAL EFFECTIVE DETECTION WIDTH
LEFT
0
RIGHT
STEERING TORQUE

Fig. 4


START
READ 1st AND 2nd TORQUE DETECTING SIGNALS T1 AND T2, SPEED SIGNAL V AND MOTOR CURRENT DETECTING SIGNAL Is.
S 1
COMPENSATE 1st TORQUE DETECTING SIGNAL T1
S 2
DETERMINE MOTOR TARGET CURRENT
S 3
CALCULATE DIFFERENTIAL VALUE ΔT1 OF 1st TORQUE DETECTING SIGNAL
S 4
CALCULATE 1st DIFFERENTIAL CURRENT Id1
Id1=K1×ΔT1
S 5
CALCULATE DIFFERENTIAL VALUE ΔT2 OF 2nd TORQUE DETECTING SIGNAL
S 6
CALCULATE 2nd DIFFERENTIAL CURRENT Id2
Id2=K2×ΔT2
S 7
S 8
SATURATE T1?
YES
NO
S 9
ADD Id1 TO TARGET CURRENT
S 10
ADD Id2 TO TARGET CURRENT
DETERMINE MOTOR TARGET VOLTAGE
S 11
DRIVE MOTOR
S 12
END

F i g . 5


1st TORQUE SENSOR
21
2nd TORQUE SENSOR
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VEHICLE SPEED SENSOR
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AMPLI-FYING CIRCUIT
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PHASE COMPEN-SATOR
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FUNCTION GENERATING UNIT
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DIFFER-ENTIATION UNIT
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MOTOR TARGET VOLTAGE CALCULAT-ING UNIT
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CONTROL UNIT
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MOTOR DRIVING CIRCUIT
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MOTOR CURRENT DETECTING CIRCUIT
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Is

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EUROPEAN SEARCH REPORT

Application Number
EP 92 11 1319

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,A	EP-A-0 460 406 (KOYO SEIKO CO., LTD.) * page 7, column 11, line 23 - page 14, column 14, line 19; claims 4,5; figures 9-12 * ---	1-8	B62D5/04
P,A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 2 (M-1197)7 January 1992 & JP-A-03 227 768 (DAIHATSU MOTOR CO LTD) 8 October 1991 * abstract * ---	1-8	
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 186 (M-962)(4129) 16 April 1990 & JP-A-02 34 469 (KAYABA IND CO LTD) * abstract * ---	1-8	
D,A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 304 (M-526)16 October 1986 & JP-A-61 115 771 (FUJI HEAVY IND LTD) * abstract * ---	1,3,5,7	
A	EP-A-0 399 405 (MITSUBISHI DENKI KABUSHIKI KAISHA) * page 3, column 4, line 18 - line 46; figure 2 * -----	1-8	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B62D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08 OCTOBER 1992	KULOZIK E.

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